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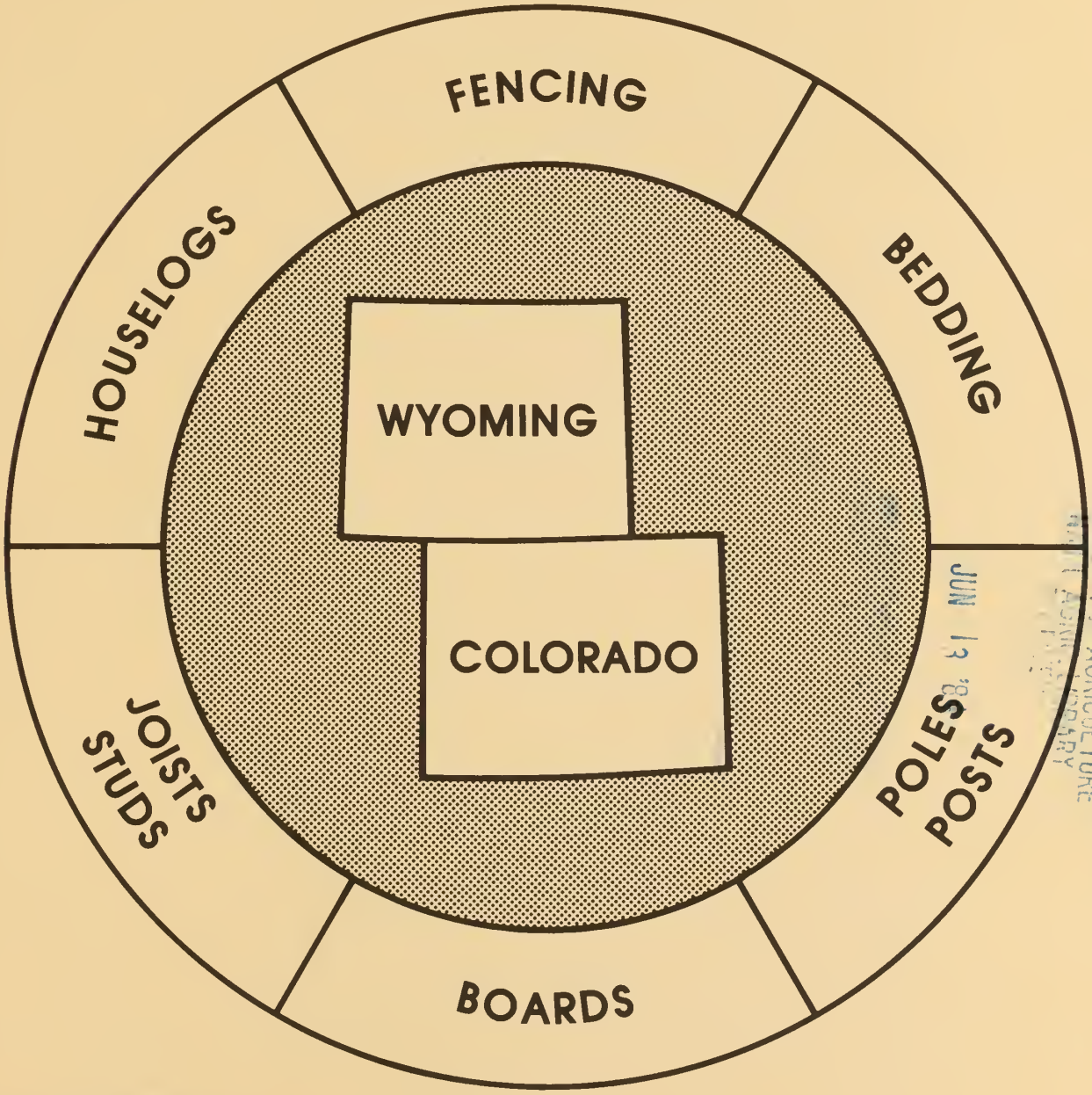

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Timber Utilization and Marketing Alternatives for Colorado and Wyoming

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Abstract

Profitable wood product mill operation in Colorado and Wyoming depends on market area, product, mill capacity, and characteristics of the available timber. This study shows how these factors affect timber marginal value and makes the connection between profitable wood products operations and the opportunities to manage woodlands.

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MANAGEMENT IMPLICATIONS

This study found that improvements in wood product producers' end-product values would indirectly increase returns to stumpage and provide opportunities for desirable multiple-use management on forested lands. For example, the linear programming analysis showed that returns to stumpage in both Colorado and Wyoming were highest when mills produced a variety of both high- and low-valued products. With product diversification, producers potentially could receive higher net returns.

Wood products serving the coal industry and energy related markets are in demand as long as these outlets are active. However, such local markets are particularly volatile because of connections with international energy markets.

Finally, transportation rates are an important determinant of profitability. Thus, valuable products such as quality boards do not necessarily provide as much net return when shipped long distances as do other products shipped to closer markets.

If diverse products are marketed from Colorado and Wyoming mills, the possibility increases that over a wide geographic area, demand for stumpage will include all commercial tree sizes, not just sawtimber. To a certain degree, this situation now occurs widely, not only in Colorado and Wyoming, but also nationally, because of the demand for firewood as well as more traditional wood products.

The analyses discussed in this bulletin are based on 1977-79 data. These data portray and reflect economic conditions in the sawmill industry at that time.

Given these data, the intent of this bulletin is twofold. First, it presents an approach to analysis of markets, products, and mill operation that may be implemented under all circumstances. Second, the results demonstrated here are generally applicable over a wide range of economic conditions. For example, product diversification is a demonstrably good strategy at any time. Further, although 1977-79 economic conditions may never be reproduced exactly, those years are representative of generally "up-beat" conditions in the lumber industry. "Up-beat" conditions in forest products will periodically prevail again, just as will future downturns. Those working in forest products industry and in management of forest land, public or private, and who are well informed on a variety of economic conditions and possible responses, will surely be positioned well to guide their operations through future continuing business cycles, both the "up" parts and the "down."

INTRODUCTION

Harvesting timber consistent with environmental safeguards is one major goal of forest resource management. Timber harvesting also must be economically worthwhile. Realizing such opportunities is a common problem in Colorado and Wyoming.

Before the 1980-82 market slump and mill closures, Colorado and Wyoming had sufficient processing capacity to handle additional timber supplies, which could have been made available by changes in forest management activities. In this region, high harvesting costs and generally low product values have been an economic disincentive to more intensive management. However, higher returns to stumpage can be gained by harvesting in areas where the timber's marginal value is high. One way to gain high marginal value for timber is with diversified product lines that tend to give mills higher net returns for wood products because raw materials are more efficiently used.

Forest resource managers and timber processors in Colorado and Wyoming need to develop and examine alternative timber utilization strategies and pursue those that best meet their mutual objectives under expected market conditions. For management to be effective, the available timber supply must be in balance not only with consumer demand, but also with the capacity of nearby industry to process and market the species and volumes of wood available. These interdependent relationships make it essential that long-range forest management planning develop sound information and projections about the availability of raw materials over time. Concurrently, planning must consider other expected resource benefits, the product potentials of available timber, consumer demand, and end-product values. To demonstrate how this might be done, several alternative strategies are presented here. These alternatives are based on information available at the time the studies were completed, 1977-79. Since that time, a major economic recession has resulted in numerous sawmill closures and major declines in forecasted energy developments. Therefore, portions of this report should be interpreted as alternatives appropriate under much improved economic conditions. Considerable restructuring of the timber industry in Colorado and Wyoming is inevitable, because several former production facilities have been dismantled. Therefore, it seems to be a particularly good time to consider new production and marketing alternatives.

Background

Several USDA Forest Service sponsored studies, upon which this report is based, appraised the potential for increasing timber harvest and utilization of two major softwood timber species groups in Colorado and Wyoming—lodgepole pine (*Pinus contorta* Dougl.) and Engelmann spruce (*Picea engelmannii* Parry)—subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.). Two studies[3] analyzed raw material supplies, mill capacities, and market demands for various wood products. A third study[4] analyzed several scenarios describing different levels of timber harvest, mill production, and market demand in order to examine a range of operating environments.

A companion study[5] examined the technical suitability of the same timber species for wood and fiber products. Many of the possible products identified were considered in the current study. Other related production and marketing studies dealt with beetle-killed ponderosa pine (*Pinus ponderosa*) in Colorado's Front Range (Sampson et al. 1980a, 1980b; Troxell et al. 1980).

Study Area

Subalpine forests are the largest and most economically valuable timber resource in Colorado and Wyoming. In Wyoming, lodgepole pine grows on about half of the commercial land in the subalpine zone. Spruce and fir are second in importance in land area, but they contain the largest volume of sawtimber, followed by lodgepole pine. In Colorado, spruce-fir occupies about one-third of the commercial forest land but contains nearly 70% of the subalpine sawtimber volume (Alexander 1974).

The study area included virtually all the "commercial forest land"[6] in Colorado and Wyoming, excluding only the eastern slope of Colorado's Front Range and the Wyoming portion of the Black Hills. Lodgepole pine is predominant on 2.3 million acres of the study area. Another 2.2 million acres is mostly Engelmann spruce mixed with subalpine fir. In southwestern Colorado, where only a small amount of lodgepole pine grows, about 370,000 acres of ponderosa pine are classified as "commercial forest land." Most of the commercial timberland in both states (about 85%) is publicly owned.[7]

Study Objectives

The overall goal of this bulletin is to assess timber utilization and marketing opportunities as a key component of overall resource management strategies. To accomplish this, there are two specific objectives.

The first is to assess three elements that are key to utilizing the resource:

1. Levels of timber supply and mill residue and the identified influences on their future availability.
2. Levels of mill processing capacities in general, and of processing capacities for specific products.
3. Analysis of markets for existing and potential products to determine the most suitable geographic areas, possible market values, and lumber consumption levels.

The second objective is to develop several scenarios that describe the effects of changes in these three key elements.

METHODS

Definition of Concepts

Timbershed

A timbershed surrounding a processing center (see next section for definition) includes forest areas where local firms usually obtain timber. The key economic factor influencing timbershed boundaries is the cost of transporting logs from the woods to the mills, as evidenced by mills' past histories of procurement. Other related influences include the surrounding topography, the existing road system, size of timber sale, timber quality and volumes, and current market conditions.

[3]*Smego, James, Robert Brenner, and David R. Betters. 1978. Assessment of wood raw material and wood utilization potential for the lodgepole pine and spruce-fir timber types in Colorado and Wyoming. Unpublished report, Colorado State University, Department of Forest and Wood Sciences, Fort Collins, Colo. Rocky Mountain Forest and Range Experiment Station Cooperative Research Agreement 16-757-CA, CSU Project 31-1470-1470, 327 p.*

Switzer, William and David R. Betters. 1980. Forest product production and marketing opportunities for utilizing the available timber resource in Colorado and Wyoming. Unpublished report, Colorado State University, Department of Forest and Wood Sciences, Fort Collins, Colo. Rocky Mountain Forest and Range Experiment Station Cooperative Research Agreement 16-869-CA, CSU Project 31-1470-2259, 153 p.

[4]*Smego, James and David R. Betters. 1979. Production and marketing alternatives for utilizing lodgepole pine in Colorado and Wyoming. Unpublished report, Colorado State University, Department of Forest and Wood Sciences, Fort Collins, Colo. Rocky Mountain Forest and Range Experiment Station Cooperative Research Agreement 16-869-CA, CSU Project 31-1470-2219, 244 p.*

[5]*Lemaster, R. L., H. E. Troxell, and F. F. Wangaard. 1979. Assessment of wood raw materials and wood utilization potential for the lodgepole pine and spruce-fir types in Colorado and Wyoming. Unpublished report, Colorado State University, Department of Forest and Wood Sciences, Fort Collins, Colo. Rocky Mountain Forest and Range Experiment Station Cooperative Research Agreement 16-927-CA, CSU Project 2243, 79 p. + appendices.*

[6]*The USDA Forest Service defines "commercial forest land" as land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. Areas qualifying as commercial forest land are capable of producing more than 20 cubic feet of industrial wood per acre per year under management.*

[7]*This estimate is obtained using data contained in a report by the USDA Forest Service. 1978. Forest Statistics of the U.S., 1977. Washington, D.C. 133 p. For precise information, see Table 5, "Area of commercial timberland in the western United States by ownership, forest type, site class, section, and region, January 1, 1977."*

Processing Center

A processing center is a location where major mill production capacity is located. Smaller mills may be scattered throughout the surrounding timbershed. Criteria for selecting processing centers are relatively large mill output levels, accessibility to large areas of timber, and good transportation facilities from woods to mill and mill to market.

Cluster

A cluster is two to four continguous processing centers combined for the purpose of marketing analyses. Clustering permits consolidation of figures, makes possible a broader use of available cost data, and avoids possible disclosure of proprietary information at certain processing centers. Figure 1 shows the five processing center clusters discussed in this study.

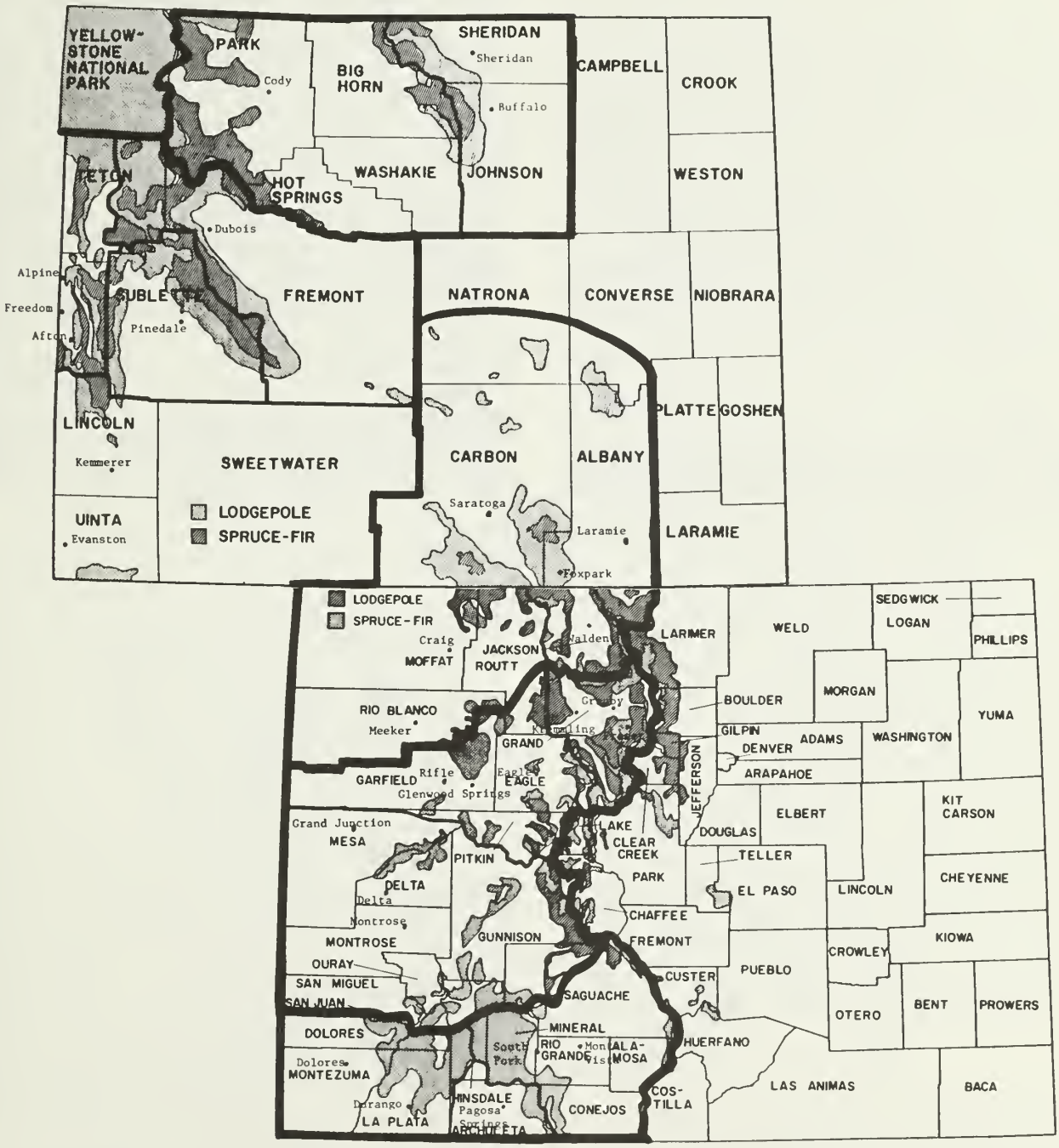

Figure 1.—Colorado and Wyoming Timber types, timbersheds, processing centers, and clusters of processing centers. In southern Colorado, light gray areas for species identification indicates ponderosa pine, not lodgepole pine.

Information and Data Obtained

Information is needed about both the supply of wood products from Colorado and Wyoming and the potential for consumption of those products.

Information was collected about existing and potential timber supplies, product lines, and mill production capacities, some of which is reported in this section even though results in general are discussed later. The study area was subdivided into 16 timbersheds or procurement areas, eight in each state (fig. 1).

The prime market area for Colorado and Wyoming wood products examined in these studies covers a large portion of the central United States, stretching from the Intermountain region and Southwest, north to Minnesota, south to Texas, and east to Ohio (fig. 2). Consumers in this area use large volumes of softwood products but are unable to obtain enough products from their local sources. In addition, these consumers are closer to the central Rocky Mountains than to other western, and in some cases southern, softwood producing areas.

Unless otherwise specified, the 1977 data reported in this study measured timber supply, production, and marketing activities and represents the most recent figures available at the time.

Timber Supply

Timber supply estimates (in thousand cubic feet, or MCF) were made from data provided by the USDA Forest Service, USDI Bureau of Land Management (BLM), and state forestry departments according to three size classes. Seedling-sapling trees are less than 5 inches d.b.h., poletimber trees are more than 5 inches d.b.h. but smaller than sawtimber, and sawtimber trees are softwoods greater than 9 inches d.b.h. and hardwoods greater than 11 inches d.b.h.

Assessments of the potential timber supply included only timber on commercial forest land. However, not all forest land classified as commercial is available for harvest. Commercial forest lands administered by the USDA Forest Service are further classified into "standard, special, marginal, and unregulated" components. "Standard" component lands are suitable and available for harvesting using normal silvicultural practices. "Special" component lands are suitable and available for timber production, but require the application of special silvicultural treatments to protect other resource values. Although "marginal" component lands are suitable for timber production, they are technically or economically unavailable at present, primarily because of excessive development costs associated with steep slopes, low product values, resource production constraints, or the absence of markets for the species or products available. "Marginal" lands also include a backlog of non-stocked areas needing reforestation. "Unregulated" lands are those lands not part of the harvest base and not included in allowable cut calculations.

Timber volumes and acreages were estimated for three harvest levels: programmed harvest, potential yield, and potential yield as affected by lands

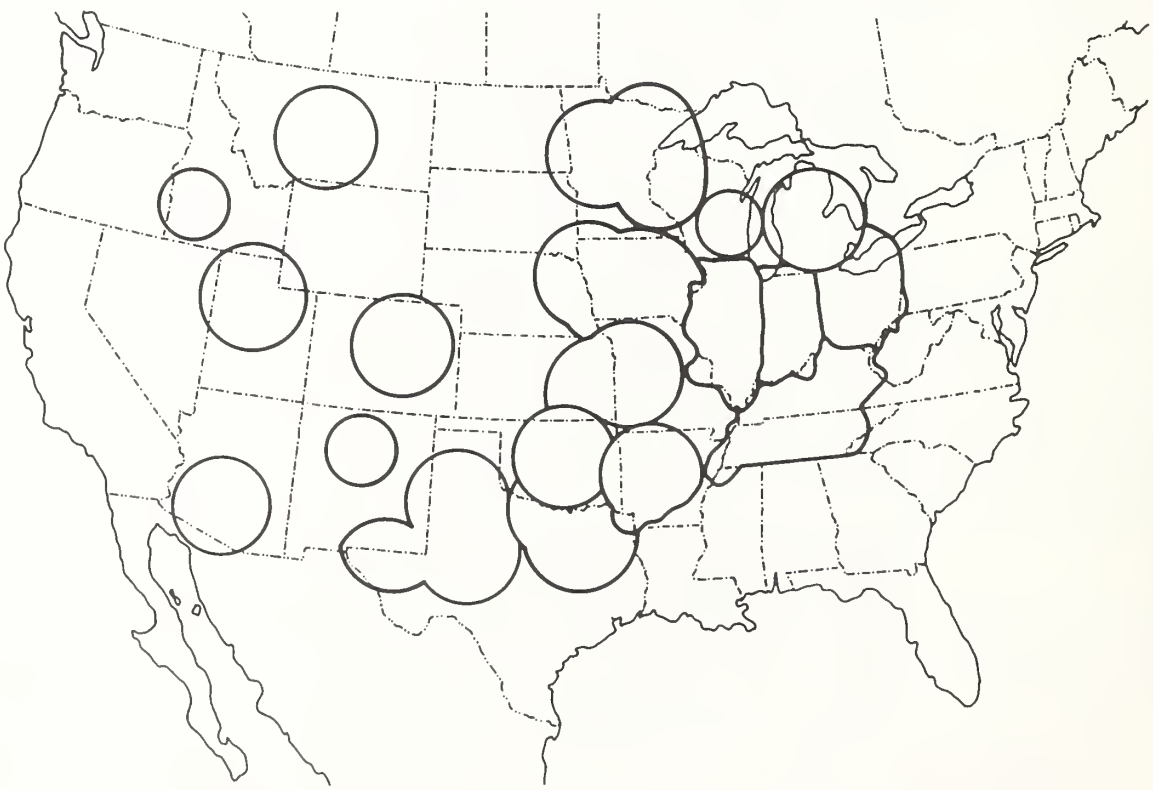

Figure 2.—Standard Metropolitan Statistical Areas that serve as loci of prime market area for Colorado-Wyoming wood products.

withdrawn from harvest during study for wilderness designation (RARE II). These categories used in USDA Forest Service management planning have been applied to all commercial forest lands in this study. "Programmed harvest" specifies the volume of timber being sold under current management plans on standard and special lands. "Potential yield" refers to the maximum level of harvest possible on a sustained-yield basis, including timber growing on marginal lands. "RARE II impacts on potential yield lands" indicates the amount acreage in standard and special components and the potential yield volumes affected by the exclusion of those areas being considered as set-asides for the national wilderness preservation system.

Data for the volumes and acreages of timber available, at each harvest level, in the five processing center clusters are summarized in table A-1 for Colorado and table A-2 for Wyoming. The original data available from USDA Forest Service management plans are classified according to their administrative areas. Therefore, the volume and acreage figures are adjusted to represent timbersheds defined on an economic basis. In the analysis portion of this study, these data helped estimate the future product potential of the timber supply.

Mill Production

The major products produced in the two states include rough and planed boards, dimension lumber, studs, timbers, houselogs, pallets, and fenceposts. Products produced in smaller quantities include railroad ties, utility poles, fencing, paneling, and firewood. Although no mills manufactured joists or particleboard, it is technically feasible with the available species of timber. Other new product possibilities include laminated beams, insulation board, fiberboard, and bedding, but market data about these products are not available for analysis in this study.

Various industry sources and state industry directories provided data for each processing center in Colorado and Wyoming.[8] For example each state traditionally publishes a directory of its forest product firms. These data described the products produced, mill capacities, and various production and marketing costs for 1977. Wherever possible, the information covered production levels by individual product lines.

Costs of stumpage, procurement, and product manufacturing are estimated from USDA Forest Service timber appraisal data.[9] Stumpage costs are represented by average costs per MCF for each species. Procurement costs include harvesting, clean-up, hauling, road building, and maintenance costs associated with timber sales. Manufacturing costs represent all costs of operating processing facilities. A profit and risk factor of 11%, frequently used by the USDA Forest Service, also applies in this analysis. Transportation costs to market vary according to the distance from the mill to various market points. Finally, handling costs cover the loading and unloading of freight at its origin and destination.

Market Area Evaluation

Wholesale market values for all products produced at each processing center were weighed against these cost figures. These values reflected competitive conditions in selected Standard Metropolitan Statistical Areas (SMSA).

Because SMSA's exhibit high levels of economic activity and population density, they also represent sites of major consumption of wood products. Groups of SMSA's are aggregated into market areas based on potential for lumber and other wood products consumption.

Several criteria helped identify SMSA's with good market potentials for Colorado and Wyoming wood products: (1) the largest markets, or SMSA's consuming the most wood products in the market area, (2) the most profitable markets for Colorado and Wyoming mills, (3) comparative advantages and disadvantages in shipping wood products to these markets, (4) trends in Colorado and Wyoming wood product consumption and production, and (5) potential increases in wood product consumption in Colorado and Wyoming resulting from coal-related energy development activities in the two states.

Demand for the region's wood products in each identified market area was assessed on the basis of the amount of lumber consumed in 1977 by the residential housing industry.[10] The 1977 consumption level was related to the number of new housing starts, as reported by the U.S. Census Bureau, multiplied by an estimate of the average amount of lumber used to build homes and apartments. Manufacturing, construction, and other non-housing consumption, which constitute a substantial part of the total, were not included because available information was difficult to associate with specific SMSA's. Thus, total consumption for each SMSA was under-estimated to the extent that non-housing uses are involved. According to the housing data, the demand for wood products appeared strongest (in descending order) in SMSA's within Illinois, Ohio, Arizona, and east Texas. Lesser demand (in descending order) existed in SMSA's in New Mexico, Arkansas, Idaho, and Montana.

Market Factor Analysis

The potential of SMSA's to serve as market areas for Colorado and Wyoming producers relates to several fac-

[8] A wide variety of resource and economic publications are published singly or in series by private, state, and federal organizations. Two sources of lists of such publications are Kallio and Dickerhoof (1979) and Donnelly (1980). Single copies of the latter paper are available from the author at USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, Colo. 80526.

[9] Each Regional Office of the USDA Forest Service compiles data about overall timber sale activity in its region. For example, data cover average costs, volumes produced, and stumpage prices among other items. These reports are filed generally under the designation 2400 which covers all phases of forest management including timber sales.

[10] At the time of the study this was the most current data available from the U.S. Census Bureau. While yearly consumption levels may change, the relative ranking of the SMSA's is normally the same each year.

tors that jointly affect profitability. These factors are net returns by market area, transportation costs, comparison of local and distant markets, and the possibility of local markets in the energy and mining industries.

Net Returns by Market Area.—To determine where Colorado and Wyoming mills could be competitive, this study estimated a product's profitability when distributed from the producer to a specific SMSA. The net return (dollar value per MCF of product remaining) is the value difference between product returns and all production costs, including transportation to market for each product line in each cluster. It appeared likely that mills could profitably market the particular product in the given market area when positive net returns are significantly large. Conversely, a large negative return indicated that a product would likely be unprofitable if marketed in the area.

Transportation Costs.—Another analysis estimated the advantages or disadvantages for Colorado and Wyoming producers when their transportation costs were compared with those of producers in adjacent states manufacturing similar products. The comparison measured truck and rail freight differences from five originating points to five key market destinations. Originating points included Colorado, Wyoming, Utah, Montana, and Idaho; and key market areas included Chicago, Ill.; Columbus, Ohio; Dallas, Tex.; Detroit, Mich.; and Phoenix, Ariz. According to published truck rates in 1978 and 1979, Colorado and Wyoming had a comparative advantage over other originating states to all of the five market areas except Phoenix, and Colorado had the advantage over Wyoming in all four instances (fig. 3). Recently, Colorado and Wyoming producers largely switched from rail to truck transportation because of favorable truck rates per unit of weight. In addition, wholesalers usually seem to incur fewer handling charges when shipping by truck, and were able to make faster and more frequent deliveries of smaller volumes.

Local and Distant Markets.—To analyze the potential of local markets, past trends in wood product production and consumption in Colorado and Wyoming were examined without forecasting trends into the future. Data came from past histories of local markets reported in wood products statistical yearbooks and U.S. Census Bureau reports. In Colorado, total lumber consumption was greater than production, with imports accounting for the difference (fig. 4). In Wyoming, total production was above both total consumption and housing unit consumption, making Wyoming a net exporter of lumber. Wyoming mills often find it more profitable to market their products out-of-state. In addition, Wyoming's production was much less erratic than Colorado's.

The Colorado-Wyoming, southern Colorado, and western Wyoming clusters have relied most heavily on the more distant markets, while the north-central Wyoming cluster has depended primarily on local market conditions. The wood products industry in Colorado and Wyoming has served primarily construction markets and, to a lesser extent, industrial markets. Mills have marketed the higher-valued products, such as joists and

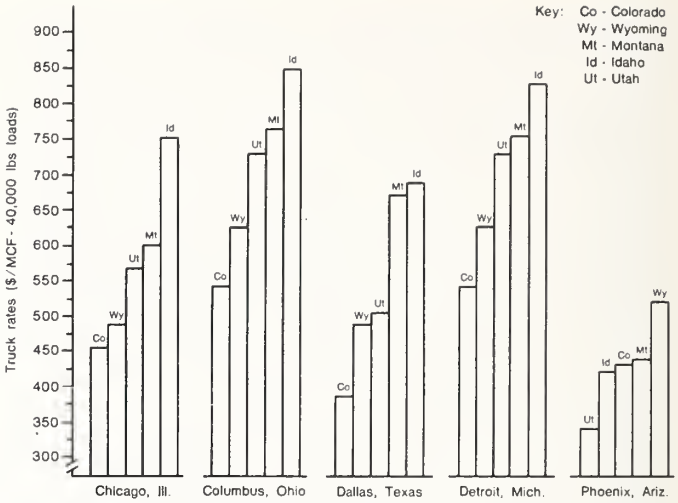

Figure 3.—Truck rates for lumber products to five key market areas.

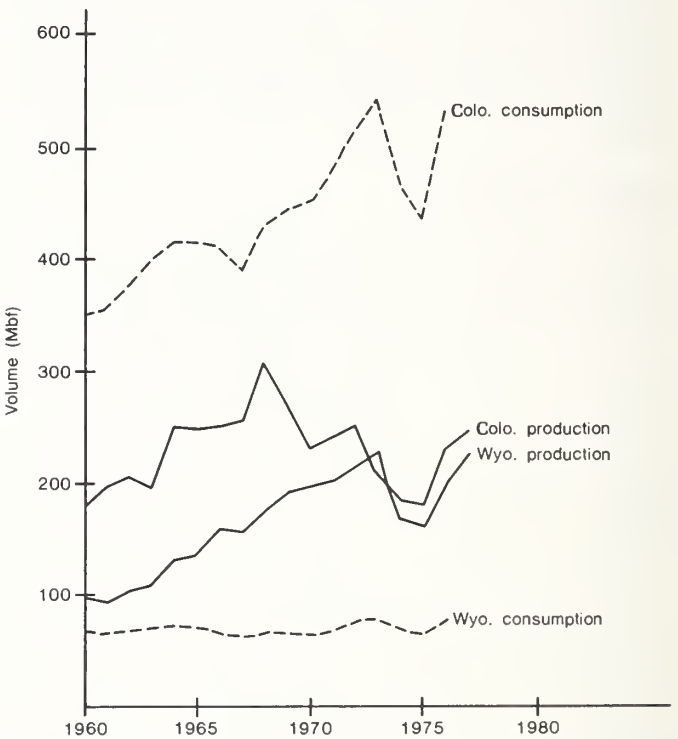

Figure 4.—Colorado and Wyoming lumber production and consumption. Source: Western Wood Products Association Statistical Yearbooks, 1977-1978. Consumption figures are based on the percentage of the total U.S. population in each state times total U.S. lumber consumption. Sources: U.S. Census Bureau and USDA Forest Service, Misc. Pubi. 1357, "The Demand and Price Situation for Forest Products, 1976-1977."

studs used in housing construction, to the more distant markets located in the upper Midwest.[11] Because these market areas show no significant local manufacture of

[11] *Mills have traditionally marketed these products outside the two states. Besides profitability, there are other factors involved including a preference on the part of local lumber wholesalers to buy lumber from areas outside of Colorado and Wyoming. The reasons for this are difficult to assess and not part of this study to determine; however, they may involve species preferences, established connections for large orders, and preconceived concerns about product quality (Sampson et al. 1980b, Donnelly et al. 1983).*

such products, the demand for high-value softwood lumber has been strong, and market prices have been high enough to absorb freight charges. Conversely, lower-valued products, such as fencing, rough boards, and houselogs, have been profitable only if sold in nearby markets. Sales of these products often are made directly to end users, such as farmers and ranchers.

In addition, total production in Colorado and Wyoming has met only a fraction of the consumption requirements for the upper Midwest (Illinois and Wisconsin). The current 10% share[12] could possibly increase to 15% under potential-yield programs. The market share in the Great Plains states (Kansas and Missouri) amounted to about 4% of the area's consumption. Considering that present marketing practices emphasize out-of-state markets, local mills supplied about 6% of local (Colorado and Wyoming) consumption, but they could provide up to 15% under potential-yield programs.

Coal Mining Markets.—Local markets for certain products in Colorado and Wyoming could increase because of coal-related energy development activities in the two states. Direct implications for wood products markets stem from the potential use of wood for mine timbers and props in underground coal mines. The extent of this market is difficult to assess, and depends on mining practices used in developing additional mine capacity. Indirect potentials would stem from any increase in housing starts in local areas and the requirements for construction products these would generate. Using projected mining and housing estimates contained in BLM Environmental Impact Statements, lumber needs for housing units and coal developments were determined. Because almost all Colorado coal mines are underground, mine timbers, props, and beams have the greatest product potential. In Wyoming, however, coal is mined at the surface; therefore, need for timbers, props and beams is expected to be much less. Housing starts related to coal energy developments are expected to be significant in both states, with the anticipated housing starts in Wyoming more than twice that of Colorado if coal becomes a major, sustained energy source. However, the outlook for timber products sold to the coal mining industry is uncertain because of the highly volatile relationships the industry has with international prices for its product and for alternative energy sources.

Linear Programming Analysis

To determine the impacts of changed timber supply levels and increased local demand resulting from related energy development and population growth, this study examined several hypothetical models of the future, or scenarios, using linear programming. Considering different levels of timber supply and local market size, a linear programming analysis identified the most profitable mix of products that could be produced by each processing center and the best markets for those products.

The defined objective for the linear programming approach was to maximize net returns, or product profitability, by finding the best allocation of product mixes to markets. Constraints on the problem, which varied for each scenario, involved three limiting factors: (1) available raw materials supplies, described by grade (green #1, green #2, or deadwood)[13] and species; (2) mill capacities for various wood products; and (3) market consumption levels for various products.

Given these constraints, the program selected the products which gave the highest profit per unit of raw materials used, and the market areas where products had the highest net returns. The program limited the choice of product mixes to those manufactured by Colorado and Wyoming producers in 1977. However, it allowed quantities produced to vary within the limits of existing mill capacities. Because it was assumed that mills could not change technology in the short run to shift production from one product line to another, this study also examined shadow prices, or opportunity costs, and suggested where increasing production capacity would be most profitable. Products with high opportunity costs are products that would yield the most profit if constraints limiting production were relaxed and more of the product could be manufactured. The opportunity costs were calculated only for those products which the mills were presently capable, to some degree, of producing.

The linear programming analyses were done in two parts based on timber species. The first part analyzed opportunities and impacts in the four processing center clusters containing primarily spruce-fir and lodgepole pine. The second part studied the processing center cluster in southwestern Colorado containing predominantly spruce-fir and ponderosa pine.

In the analysis focused on spruce-fir and lodgepole pine, the scenarios represent a wide range of possible production levels, harvest levels, and market demands. "Current" refers to 1977-79 levels.

Scenario

1. Current mill production and current programmed harvest level.
2. Current mill production and potential-yield harvest level.
3. Current mill production and potential-yield harvest on all lands except RARE II wilderness areas.[14]

[12] *These percentages were based on the portion of Colorado and Wyoming lumber production shipped to those locations and the total lumber consumption in those states estimated from state housing start figures published by the U.S. Department of Commerce.*

[13] *These grades were derived by using USDA Forest Service timber sale appraisal data and mill information concerning the amount of resource material suitable to make certain products. For example, green #1 is the raw material suitable to make higher-valued products, such as boards. Green #2 is material suitable for products such as dimension lumber. Deadwood is to be used for firewood.*

[14] *RARE II wilderness areas refer to those lands now under Congressional review for wilderness designation and which are likely to be included in the wilderness system soon.*

4 Current mill production and potential-yield harvest on all lands except RARE II wilderness areas and further planning areas where defined.
5 Potential mill production and potential-yield harvest.
6 Potential mill production and potential-yield harvest on all lands except RARE II wilderness areas and further planning areas.
7 Potential mill production and potential-yield cut on all lands except RARE II wilderness areas and including new markets from local energy developments.

In the analysis focused on spruce-fir and ponderosa pine in southwestern Colorado, the scenarios remained basically the same, excluding only the RARE II areas under further planning mentioned in scenarios 4 and 6. Lack of merchantable timber in these RARE II areas will have negligible effect on the linear programming solutions.

Data for these models and the linear programming solutions are taken from the preliminary reports of this study.[3,4,5] Coefficients in the linear programs varied by product, market distance, or species, and were based on 1977 data, the most recent year for which data were available when this work was done.

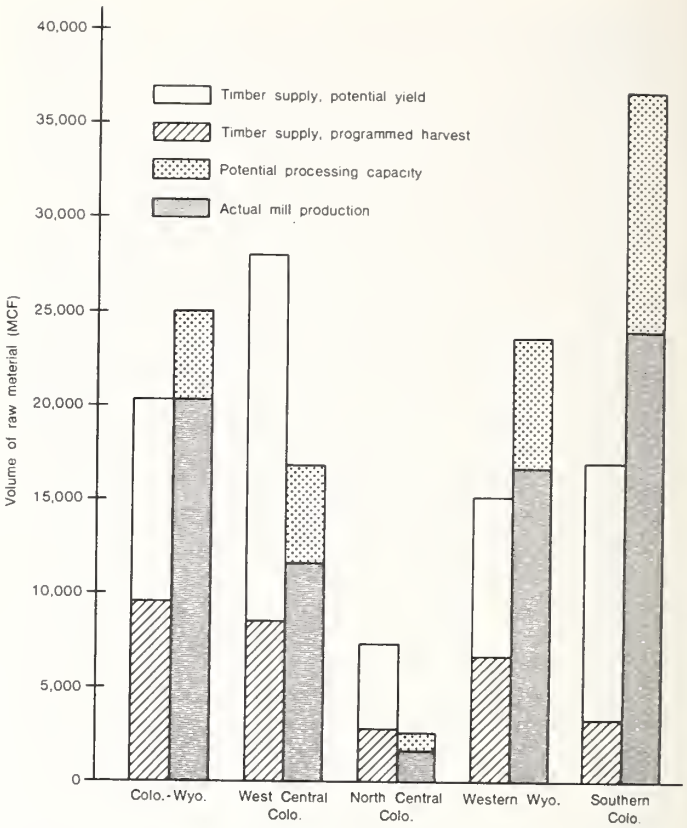

Figure 5.—Timber supply in 1977 compared to production capacity for selected clusters of processing centers. The actual and potential production capacities represent volumes necessary to produce dimension lumber, assuming a similar product mix for each cluster.

RESULTS AND DISCUSSION

The linear programming solutions describe several alternatives for timber management and wood products marketing. These alternatives indicate how changes in the timber supply, changes in market size because of energy development, and mill capacity restrictions affect net returns to mills and the optimal allocation of product mixes to markets. Because timber supply was the major limiting factor, the greatest opportunities for increasing net returns involve changing timber harvest levels.

Several opportunities exist for expanding timber supply from programmed harvest to the potential-yield level. Many Colorado and Wyoming producers did not manufacture products at full capacity and used only a small percentage of the timber that could have become available under potential-yield programs in their own timbersheds (fig. 5). For example, the southern Colorado and western Wyoming clusters had about one-third excess mill capacity, while the Colorado-Wyoming cluster had about one-fifth excess mill capacity. Because the potential mill capacity in these three clusters exceeded potential timber harvest levels, these clusters could readily take advantage of potential-yield programs; but the north-central Wyoming and west-central Colorado clusters would require additional mill expansion and investment to use more timber.

Figure 5 also shows that, in most clusters, timber volume cut in 1977 (roughly equivalent to mill production) was significantly greater than volume sold (programmed harvest) that year. Producers harvested timber sold to them in prior years to meet strong demand in products markets, particularly in housing. Thus, considering programmed harvest levels and available standing timber sold earlier, 1977 mill production figures were probably close to maximum.

Within each market cluster, the effects of RARE II wilderness restrictions on potential yields were minimal. The linear programs showed that, if the RARE II lands[14] were withdrawn from harvesting consideration, some processing centers with tight raw material supplies and with limited acres of standard- and special-component lands could become slightly more dependent on marginal lands for their timber supply, particularly in the Monte Vista-South Fork, Buffalo-Sheridan, Pinedale, Afton-Freedom-Alpine, and Evanston timbersheds. However, these impacts were limited to a few processing centers and were not characteristic of any entire market cluster.

Many opportunities also exist for directly improving producers' end-product values, thus, indirectly increasing returns to stumpage and providing opportunities for conducting additional multiple-use activities on forested lands. One way to increase returns to stumpage would be to concentrate timber harvests in areas where values of additional stumpage (opportunity costs) are high, indicating that market demand for raw materials exceeds

supply (fig. 6). In Colorado and Wyoming, the analyses showed that returns to stumpage were highest where a variety of high- and low-valued products were produced. For both the Colorado-Wyoming and west-central Colorado clusters, recent killed deadwood was worth almost as much as green raw material because of limits on green material available, the product mixes produced, and large raw material requirements.

Returns were generally higher for spruce-fir than for lodgepole or ponderosa pine in all clusters, except the north-central Wyoming cluster. This difference in value was most significant in western Wyoming, where the product mix was dominated by studs, for which spruce is well suited. Lodgepole pine stumpage was worth the most in the Colorado-Wyoming cluster, and spruce-fir stumpage was worth the most in western Wyoming. Overall, the best immediate opportunities to increase stumpage returns, by as much as 50%, are in western Wyoming and southern Colorado under intensive timber management programs (table 1).

By changing the raw material or mill capacity levels in the linear programming models, it was possible to evaluate potential changes in stumpage prices. If additional raw material became available and mill capacities remained the same, stumpage prices should drop, especially if excess raw materials were used to manufacture lower-valued products. However, stumpage prices could rise if mills expanded production capacity or shifted production to higher-valued product mixes.

Using opportunity costs as a criterion for investment in timber management simultaneously considers the area's raw material market and manufacturing capabilities. This is different from traditional analysis of timber investments which have been based primarily on site productivity, using either present net worth or internal rate of return on a stand basis to assess investment possibilities. However, from an economic standpoint, it makes sense to initially make investments where the returns to stumpage are greatest and then schedule subsequent investments for other market clusters in decreasing order of stumpage value. Looking at this study's opportunity costs at the programmed-harvest level and at the margin, investments in the Colorado-Wyoming, western Wyoming, and southern Colorado clusters appear most worthwhile.

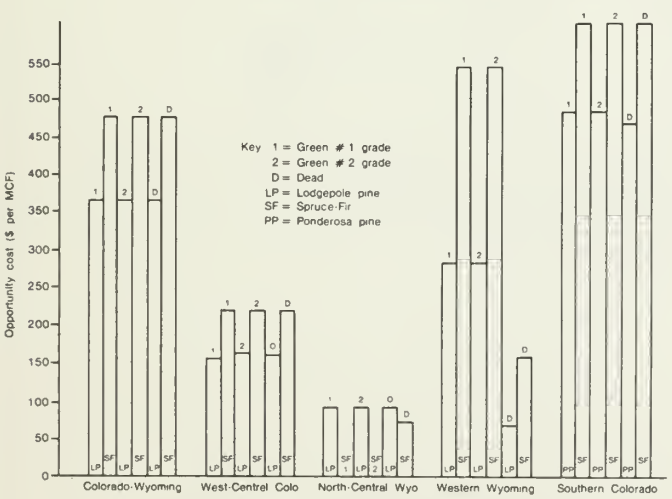

Figure 6.—Opportunity costs for stumpage.

The linear programming alternatives did not indicate a need to change product mixes, except where one or two products dominated production. In Colorado and Wyoming, producers were able to obtain higher net returns for wood products when they diversified their products lines (table 1). The Colorado-Wyoming cluster produced many product lines ranging from high to low values and, as a result, more completely used its raw materials. In contrast, the western Wyoming cluster produced large volumes of studs for which the raw material supply was limited. Consequently, mills in this cluster often used material for studs that also was suitable for other products.

The need for product diversification is important in Colorado and Wyoming, because there currently are no outlets for fiber-type uses, such as pulp and paper or composition board. Similarly, mills should diversify, because the high cost of timber extraction and, in some cases, restrictions on timber supply call for a high degree of efficiency in raw material utilization.

This study demonstrated that changes in local market size did not appreciably affect total production in the two states because production was not previously geared to satisfying demand in the market area. Regional growth in Colorado and Wyoming resulting from energy and other development may create requirements for timbers and housing materials in specific locations, with this demand probably exceeding local production, even under intensive timber management programs with all production being marketed locally. Only about 8% of the mine timbers needed to meet estimated 1977 coal-related energy development requirements were produced in the two states, primarily for Colorado's underground mines. Energy-related housing needs, if they should occur on a sustained basis, are much less for Colorado than Wyoming. Producers in the two states can meet approximately 50% of the expected increase in the Colorado demand for quantities of housing associated with energy development under the programmed harvest level. The west-central Colorado cluster is close to the area where local energy developments may occur and would experience low transportation charges. Local mills in this cluster could supply up to 85% of the energy-related housing needs under potential-yield programs if continuing energy development becomes economic in that area. Because Wyoming mills exported a large percentage of their production, they were able to meet only 7% of Wyoming's 1977 housing demand. However, with improved marketing and higher stumpages prices, local mills could supply a higher percentage of the need. In any case, producers that attempt to meet these housing demands could conceivably use all their capacity to satisfy local markets.

In the future, it seems clear that both states will continue to import wood products to meet their many needs. Economic efficiency, however, suggests the greatest possible utilization of local products be encouraged.

Table 1.—Comparison of residual values, excess mill capacity and excess raw material by market cluster for scenarios 1-7.

Cluster	Residual	Excess mill capacity[1]	Excess raw material[1]
Scenario 1: Current mill production with programmed cut			
Colorado-Wyoming	$9,025,000	2,855	0
West-Central Colorado	4,161,700	418	0
North-Central Wyoming	914,170	0	878
Western Wyoming[2]	3,072,000	2,931	0
Southern Colorado	3,051,000	6,364	0
Scenario 2: Current mill production with potential yield			
Colorado-Wyoming	10,623,000	0	1,610
West-Central Colorado	4,776,700	0	16,354
North-Central Wyoming	1,003,400	0	4,871
Western Wyoming[2]	5,830,000	645	0
Southern Colorado	7,905,900	1,745	0
Scenario 3: Current mill production with potential yield less RARE II instant wilderness areas			
Colorado-Wyoming	10,540,000	0	208
West-Central Colorado	4,762,100	0	13,888
North-Central Colorado	1,003,300	0	4,863
Western-Wyoming[2]	5,732,800	716	0
Southern Colorado	7,849,800	1,830	0
Scenario 4: Current mill production with potential yield less RARE II instant wilderness and further planning areas			
Colorado-Wyoming	10,536,000	0	136
Western Wyoming[2]	5,627,000	791	0
Scenario 5: Potential mill capacity with potential yield			
Colorado-Wyoming	12,604,000	529	0
West-Central Colorado	6,814,500	0	11,912
North-Central Wyoming	1,388,600	0	4,199
Western Wyoming[2]	6,394,900	2,563	0
Southern Colorado	10,426,000	5,661	0
Scenario 6: Potential mill capacity with potential yield less RARE II instant wilderness and/or further planning areas			
Colorado-Wyoming	12,481,000	1,039	0
West-Central Colorado	6,799,900	0	9,446
North-Central Wyoming	1,388,500	0	4,190
Western Wyoming[2]	6,189,600	2,709	0
Southern Colorado	10,370,000	5,747	0
Scenario 7: Potential mill capacity with potential yield less RARE II instant wilderness areas with local energy impact markets			
Colorado-Wyoming	12,515,000	1,014	0
West-Central Colorado	6,841,000	0	9,447
North-Central Wyoming	1,388,500	0	4,190
Western Wyoming	6,296,300	2,634	0
Southern Colorado	10,370,000	5,747	0

[1]*Excess mill capacity is in terms of mcf product, and excess raw material is in terms of mcf raw material.*

[2]*Assumes all deadwood is utilized for firewood, and not other products.*

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Table A-1.—Summary of estimated areas and volumes for procurement areas in Colorado[1]

Processing center clusters	Colorado-Wyoming[2]				West-Central Colorado					
Processing centers	Walden		Craig-Meeker		Delta-Montrose		Eagle-Rifle-Glenwood Springs		Granby-Fraser-Kremmling	
	Acres	Mcf[3]	Acres	Mcf	Acres	Mcf	Acres	Mcf	Acres	Mcf
Living material										
Total sawtimber	90,116	212,199	134,931	260,717	394,794	844,537	146,154	321,711	187,876	465,377
Total poletimber	123,422	209,642	129,641	239,197	274,402	355,538	132,768	251,916	132,248	198,111
Total seedlings and saplings	26,089	6,056	40,957	9,094	54,071	11,778	37,948	5,156	50,474	12,529
Total living material	239,627	427,897	305,529	509,008	723,267	1,211,853	316,870	578,783	370,598	676,017
Dead material										
Sawtimber annual mortality	68,446	1,337	100,532	1,912	N/A	1,368	111,078	1,898	139,544	1,767
Poletimber annual mortality	59,247	835	80,307	1,115	N/A	874	60,412	766	72,836	875
Total dead material	127,693	2,172	180,839	3,027	N/A	2,242	171,490	2,664	212,380	2,551
Total non-CFL	15,176	N/A	47,584	N/A	377,440	N/A	153,150	N/A	189,391	N/A
Total potential yield	2,131	3,360	110,853	7,060	273,360	26,588	135,729	7,027	116,714	7,851
Total programmed allowable cut	1,346	1,374	5,773	2,714	5,200	3,946	20,099	3,508	22,738	3,472
Rare II impacts on potential yield										
Standard component	64,026	([4])	143,943	1228.8	127,339	182.0	123,400	1262.4	24,214	156.4
Special component	879		3,644	[5]8.0	64,617	30	12,709	8.0	58,744	414.4
Total standard & special	64,905	1643	147,587	2812.8	191,956	212	136,109	1270.4	82,958	570.8
Total gross area[6]	130,100		394,270		153,340		908,090		214,010	

Table A-1.—Summary of estimated areas and volumes for procurement areas in Colorado[1]—Continued

Processing center clusters	Southern Colorado					
Processing centers	South Fork Monte Vista		Durango-Dolores		Pagosa Springs	
	Acres	Mcf	Acres	Mcf	Acres	Mcf
Living material						
Total sawtimber	258,690	397,652	137,630	261,965	93,270	183,190
Total poletimber	88,960	79,669	72,003	122,683	43,133	80,877
Total seedlings and saplings	45,759	8,392	8,826	1,908	5,086	1,098
Total living material	393,409	485,713	218,459	386,556	141,489	265,165
Dead material						
Sawtimber annual mortality	N/A	330	N/A	935	N/A	539
Poletimber annual mortality	N/A	532	N/A	125	N/A	72
Total dead material		862		1,060		611
Total non-CFL	231,192	N/A	108,609	N/A	62,591	N/A
Total potential yield	53,690	7,721	100,435	8,790	73,255	5,422
Total allowable cut	5,900	3,990	N/A	1,226	N/A	366
Rare II impacts on potential yield						
Standard component	205,400	142	4,000	22	26,800	136
Special component	7,166	18	-0-	-0-	27,300	4
Total standard & special	212,566	160	4,000	22	54,100	140
Total gross area[6]	924,630		428,940		318,210	

[1]*Includes Forest Service, BLM, and state and private lands. This total includes raw material classifications where acreage or volumetric data were not available in summing values for a given procurement area. Therefore, the totals presented in this table are less than actual-on-the-ground resources. Further, data concerning volumes and acres come from several sources. Not all categories of data were available from each source. Thus, volume and acre figures must be considered independent and using them together, for example, to calculate a volume/acre/year figure, is not possible in many cases.*

[2]*The Colorado-Wyoming cluster includes processing centers and timbersheds that are in both states. See table A-2.*

[3]*Mcf - thousand cubic feet.*

[4]*Standard and special potential yield volumes not broken down by standard or special classifications.*

[5]*Includes additional standard and special volumes which could not be broken down into each component.*

[6]*Gross acres of RARE II areas within procurement area. At the time of this study the final environmental impact statement was not available and categorization of RARE II land was not completed. The figures presented here assume all areas specified in 1978 would be included in the wilderness system.*

Table A-2.—Summary of estimated areas and volumes for processing center timbersheds in Wyoming[1]

Processing center clusters	Colorado-Wyoming[2]				North Central Wyoming			
Processing centers	Laramie-Foxpark		Saratroga		Cody		Buffalo-Sheridan	
	Acres	Mcf[3]	Acres	Mcf	Acres	Mcf	Acres	Mcf
Living material								
Total sawtimber	142,457	185,265	127,705	240,939	87,320	169,492	116,185	200,874
Total poletimber	65,555	92,903	60,624	144,970	45,383	57,345	60,581	75,367
Total seeds and saps	19,797	1,066	18,749	547	27,802	5,670	29,819	11,250
Total living material	227,809	279,234	207,078	356,456	160,505	232,507	206,585	287,491
Dead material								
Sawtimber annual mortality	125,298	2,243	106,794	1,386	N/A	452	N/A	597
Poletimber annual mortality	63,639	587	48,758	1,555	N/A	278	N/A	330
Total dead material	188,937	2,830	155,552	2,941	N/A	730	N/A	927
Total non-CFL	47,455	N/A	32,902	N/A	258,353	N/A	83,199	N/A
Total potential yield	2,861	5,600	3,553	6,579	4,134	3,450	5,991	4,306
Total allowable cut	2,688	2,822	3,008	3,532	1,979	1,316	2,443	1,371
Rare II impacts on potential yield								
Standard component	38,375	90.0	79,890	188.0	20,505	56	97,350	128
Special component	6,332	26.0	2,480	6.0	31,738	64	95,691	109
Total standard & special	44,707	116.0	82,370	194.0	61.243	120	193,041	237
Total gross area[6]	289,980		203,620		665,209		419,470	

Table A-2.—Summary of estimated areas and volumes for processing center timbersheds in Wyoming[1]—Continued

Processing center clusters	Western Wyoming							
Processing centers	Dubois		Pinedale		Afton-Freedom Alpine		Evanston	
	Acres	Mcf	Acres	Mcf	Acres	Mcf	Acres	Mcf
Living material								
Total sawtimber	283,958	562,996	196,237	467,646	345,197	686,322	145,331	256,220
Total poletimber	55,129	19,444	92,557	26,993	166,625	78,719	109,187	37,069
Total seeds and saps	6,042	N/A	3,360	35	17,934	108	18,543	1,073
Total living material	345,129	582,440	292,154	494,674	529,756	765,149	273,061	294,362
Dead material								
Sawtimber annual mortality	N/A	4,273	N/A	4,489	N/A	7,593	N/A	1,756
Poletimber annual mortality	N/A	1,572	N/A	923	N/A	1,858	N/A	343
Total dead material	N/A	5,845	N/A	5,412	N/A	9,451	N/A	2,099
Total non-CFL	271,241	N/A	298,854	N/A	290,318	N/A	134,587	N/A
Total potential yield	18,736	4,349	1,719	3,181	4,395	13,630	1,303	1,834
Total allowable cut	18,602	2,708	1,714	1,950	5,805	2,052	1,737	1,728
Rare II impacts on potential yield								
Standard component	13,834	(4)	9,879	(4)	93,628	840.7	95,874	300
Special component	34,922		54,094		186,068	4157.9	52,773	38
Total standard & special	48,756	4,576	63,973	4,527	279,696	6591[5]	148,647	1,170[5]
Total gross area[6]	462,859		388,334		1,465,322		567,700	

[1]*Includes Forest Service, BLM, and state and private lands. This total includes raw material classifications where acreage or volumetric data were not available in summing values for a given procurement area. Therefore, the totals presented in this table are less than actual-on-the-ground resources. Further, data concerning volumes and acres come from several sources. Not all categories of data were available from each source. Thus, volume and acre figures must be considered independent, and using them together, for example, to calculate a volume/acre/year figure, is not possible in many cases.*

[2]*The Colorado-Wyoming cluster includes processing centers and timbersheds that are in both states. See table A-1.*

[3]*Mcf - thousand cubic feet.*

[4]*Standard and special potential yield volumes not broken down by standard or special classifications.*

[5]*Includes additional standard and special volumes which could not be broken down into each component.*

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Profitable wood product mill operation in Colorado and Wyoming depends on of market area, product, mill capacity, and characteristics of the available timber. This study shows how these factors affect marginal value and makes the connection between profitable wood products operations and the opportunities to manage woodlands.

Keywords: Utilization, marketing, forest products, Colorado, Wyoming.

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Rocky Mountains

Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

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